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Art. VII.—*An Upper Oligocene Bryozoan Faunule.*

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Introduction.

The forms listed below were obtained from approximately 40 cc. of matrix in the National Museum collections taken from 66-67 feet in the Torquay bore (Chapman, 1922). This faunule, though scanty, is interesting, because of the occurrence of well-preserved specimens of *Otionella cupola spiralis* (Chapman, 1913), and the extension of the range of *Cellaria depressa* Maplestone, 1900, to the Upper Oligocene. Notes on three of the species of the faunule are given below. The great predominance of cellariform elements in the sample suggests that deposition took place in shallow water (10-15 fathoms) subject to strong wave action (Stach, 1936).

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List of Species.

Otionella cupola spiralis (Chapman, 1913). O–M.
Cellaria australis Macgillivray, 1880. O–R.
Cellaria contigua Macgillivray, 1895. O–P.
Cellaria depressa Maplestone, 1900. O–M.
Cellaria rigida perampla Waters, 1882. O–P.
Cellaria rigida venusta Macgillivray, 1895. O–M.
Cellaria robusta Maplestone, 1902. O–M.
Cucullipora tetrasticha Macgillivray, 1895. O–M.
O = Oligocene, M = Miocene, P = Pliocene, R = Recent.

Notes on the Species.

Family CELLARIIDAE Hincks, 1880.

Genus **Cellaria** Ellis and Solander, 1786.

Cellaria depressa Maplestone, 1900.

Cellaria depressa Maplestone, 1900, p. 167, pl. xviii., fig. 15; *idem*, 1904, *b*, p. 193.

Distribution.—Lower Miocene. The following localities are additional to those listed by Maplestone (1904, *b*):—Batesford tunnel marl; Balcombe Bay; Mitchell River at Bairnsdale; Clifton Bank (Muddy Creek, Hamilton).

Upper Oligocene: 66-67 feet in the Torquay bore; "Glycimeris bed" (Torquay).

Family MEMBRANIPORIDAE Busk, 1854.

Genus **Otionella** Canu and Bassler, 1917.

Otionella cupola (Tenison Woods, 1879).

(Pl. III., Fig. 3; text figs. 2, 3-5.)

Lunulites exigua T. Woods, 1879, p. 8, pl. ii., figs. *7a-c*.

Lunulites cupola idem, 1879, p. 8, pl. i, figs. *5a-c*.

Lunulites petaloides Waters (*non* d'Orbigny, 1852), 1883, p. 442.

Selenaria cupola (T. Woods), Macgillivray, 1895, p. 49, pl. vii., fig. 14. Maplestone, 1904, *a*, p. 210; *idem*, 1904, *b*, p. 198. Chapman, 1916, p. 387; *idem*, 1922, pp. 317-319; *id.*, 1928, p. 148.

Observations.—The type material of this species (preserved in the Tate Museum, Adelaide University) consists of a series of five zoaria of "*Lunulites exigua*" from Mount Gambier and eight zoaria of "*Lunulites cupola*" from Muddy Creek, Hamilton (lower beds). The zoaria of each series have been treated as syntypes (labelled alphabetically) since it cannot be decided which specimens were figured.

The two series of syntypes were compared and the opinion of Maplestone (1904, *a*) as to their conspecificity is confirmed. The zoaria from Mount Gambier ("*Lunulites exigua*") are abraded and partly obscured by secondary deposition of calcite, while the dimensions are proportionately smaller than the average for the species, the last-named feature being due probably to the contemporary local environment. The zooecial and vibracular detail which can be made out agrees with that of the Muddy Creek specimens ("*Lunulites cupola*"). The characteristic development of the zoarium up to the stage A 4, B 4 (Figs. 5, 6) can be seen in both series of syntypes.

Maplestone, the first reviser of these forms, chose the name "*cupola*" for the revised species, and this name must stand although "*exigua*" has page precedence (Art. 28, Internat. Rules Zool. Nomen.).

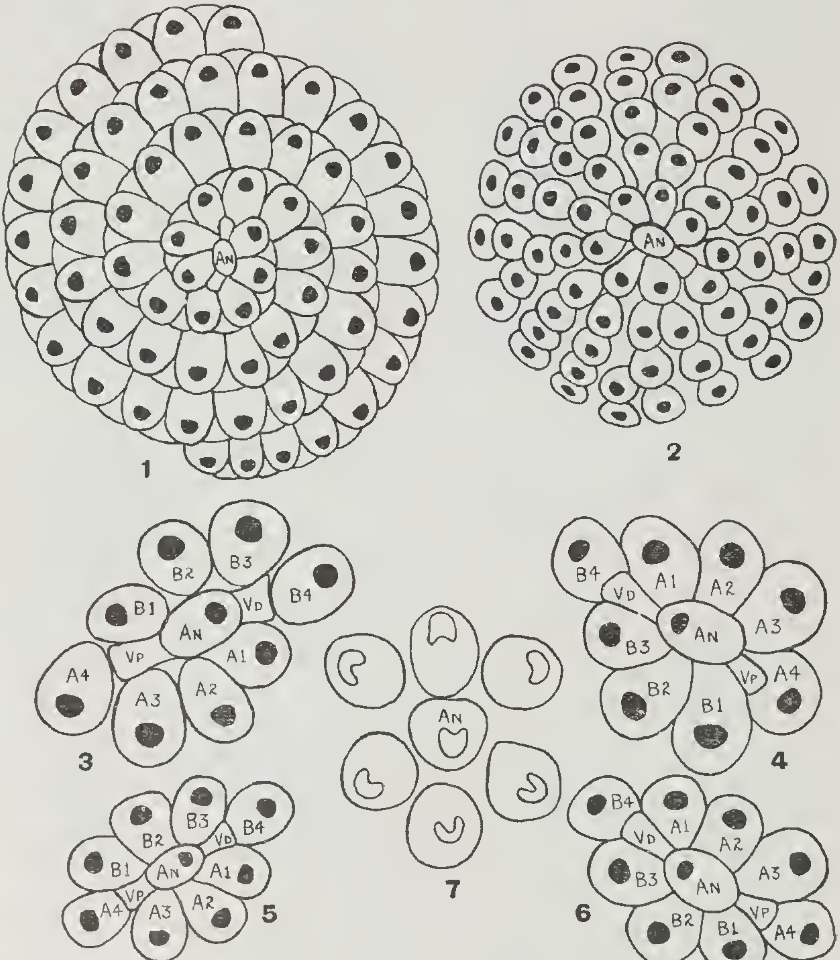
Maplestone (1904, *a*) has placed the New Zealand Tertiary form, *Selenaria squamosa* T. Woods, 1880, with this species, but an examination of the types of *S. squamosa* (by courtesy of the New Zealand Geological Survey) shows that the vibracula of this form have the large cribriform frontal area typical of *Selenaria*.

Otionella cupola spiralis (Chapman, 1913).

(Pl. III., Figs. 1, 2; text figs. 1, 3.)

Selenaria marginata var. *spiralis* Chapman, 1913, p. 184, pl. xviii., fig. 33; *idem*, 1916, pp. 377, 387, pl. lxv., fig. 33.

Affinities.—The ancestrular region of the poorly preserved holotype (Nat. Mus. Coll. No. 12456) has been abraded off,



Figs. 1-7.—Schematic outline camera lucida drawings of zoaria and ancestrular regions of *Otionella cupola* and *Selenaria concinna.*

Fig. 1. Zoarium of *Otionella cupola spiralis* (Chapman) from Torquay Bore at 66-67 feet, illustrating clockwise double spiral mode of development of the whole zoarium. X 20. Fig. 2. Zoarium of *O. cupola cupola* (T. Woods) from "*Glycimeris* bed" at Torquay, illustrating distal budding of zooecia following spiral development of ancestrular region. X 20. Fig. 3. Ancestrular region of *O. cupola spiralis* from Torquay Bore at 66-67 feet. X 40. Fig. 4. Ancestrular region of *O. cupola cupola* from "*Glycimeris* bed" at Torquay. X 40. Fig. 5. Ancestrular region of Syntype C of "*Lunulites exigua*" from Mount Gambier. X 40. Fig. 6. Ancestrular region of Syntype G of "*Lunulites cupola*" from Muddy Creek, Hamilton (lower beds). X 40. Fig. 7. Ancestrular region of *Selenaria concinna* T. Woods from Clifton Bank, Muddy Creek (Hamilton). X 40. An, ancestrula; A1-A4, earliest zooecia of the distal spiral; B1-B4, earliest zooecia of the proximal spiral; Vd, distal vibraculum; Vp, proximal vibraculum.

but the younger zooecia permit a definite correlation with *Otionella cupola* in the form and dimensions of the aperture, the dimensions of corresponding zooecia in zoaria of *O. cupola spiralis* from the present locality and particularly in the form of the vibraculum, that of *Selenaria marginata* being much expanded proximally, whereas in *O. cupola* the vibraculum is narrow in the proximal region. The ancestrular region of *S. marginata* differs markedly from that of *O. cupola*, but corresponds closely with that of *Selenaria concinna* T. Woods, 1879 (*cf.* figs. 3 and 7).

Zooecia and vibracula.—A comparison of the characters of the zooecia and vibracula of *O. cupola cupola* and *O. cupola spiralis* reveals no character by which they could be separated. The dimensions of the zooecia are variable on the same zoarium, but a measurement taken between the distal edges of zooecia A 4—B 4 is significant (Fig. 3). In *O. cupola spiralis* six zoaria gave a measurement of 0.95 mm. and two a measurement of 1.0 mm. For several zoaria from varying horizons and positions in the "*Glycimeris* bed" at Torquay *O. cupola cupola* gave a range from 0.85–1.15 mm., the mean of which agrees closely with that of the former variety. The range in the measurements of *O. cupola cupola* is probably due to varying environmental conditions since the zoaria came from several sources whereas, in the case of *O. cupola spiralis*, only about 40 cc. of matrix from the one source yielded the specimens.

The only distinction between *O. cupola spiralis* and *O. cupola cupola* is the mode of zoarial development.

Zoarial development.—The substratum for the zoarium in all observed cases was a glauconite grain. The ancestrula, which is of the same character as the zooecia, buds off two vibracula, one at the proximal end and the other at the distal end, the former probably being developed to maintain the balance of the young zoarium. In the angle on the right side between the distal vibraculum and the distal half of the ancestrula and in the angle on the left side between the proximal vibraculum and the proximal half of the ancestrula, the first two zooecia (A 1, B 1) are developed. From the right hand side of each of these is budded laterally a zooecium which abuts on the remainder of the lateral wall of the ancestrula on each side (A 2, B 2). The third pair of zooecia (A 3, B 3) are budded laterally from the preceding pair, their proximal ends abutting on the left lateral walls of the vibracula. The fourth pair of zooecia (A 4, B 4) arise in similar fashion, their proximal ends abutting on the distal wall of each vibraculum. The succeeding zooecia are budded laterally from the right side of each preceding zooecium and thus the zoarium is formed of two clockwise spiral series of zooecia. The latest zooecia of each spiral composing the zoarium are always seen to be on opposite sides of the zoarium and counts of the zooecia in each spiral for several zoaria gave the following results: 31, 30; 30, 30; 28, 26; 26, 25; 19, 18; 18, 17; 15, 14. These figures illustrate that the budding rate is the same in each spiral, probably being controlled by the need of the zoarium to maintain its balance.

In *O. cupola cupola* the development up to the stage of A 4, B 4 (Fig. 4) is essentially the same as described above except that various minor irregularities in the positions of the earlier zooecia occur and in a few cases additional zooecia are interpolated in the original series. When the ancestrula and its pertaining vibracula have become completely surrounded by zooecia, budding takes place from the distal ends of the zooecia (Fig. 2), the resulting zoarium being circular in outline. This later development of higher symmetry in the zoarial form appears to be correlated with the maintenance of balance by the zoarium.

The only other case in which a double spiral development of the zoarium is known is that of the recent *Heliodoma implicata* Calvet, 1906, from Madeira, but there is no close genetic connexion between these two forms since there is no relation in the early development of the zoarium and the great development of the elongate opesium in *Heliodoma* contrasts strongly with the small subcircular opesium of *Otionella*. The sporadic occurrence of this type of zoarial form and, in the case of *O. cupola spiralis*, its correlation with a form having a lunulitiform zoarium suggest that the significance of this type of development is small. It is suggested that *Heliodoma* belongs to the widely-distributed, better-known genus *Cupuladria* Canu and Bassler, 1920, for the following reasons.

Apart from the difference in zoarial form, Canu and Bassler (1920, p. 24) state that these genera differ only in the place of the vibracula. Actually the difference in situation is only apparent and of little morphological importance. In *Cupuladria* it is obvious that each vibraculum develops as a distal bud from each zooecium. The mode of development of the colony of *C. canariensis* (Busk, 1859) (the genotype) is such that each vibraculum is finally situated proximal to the longitudinal plane of symmetry of the distal zooecium, while the long axis of the vibracular aperture is acutely inclined to that of both proximal and distal zooecia. An examination of Calvet's figure of *Heliodoma implicata* indicates the same mode of development of the vibraculum, but the situation of the vibraculum appears to be between the distal ends of adjacent zooecia, this being due to the mode of development of the colony, for the figure shows that the latest zooecia of both spirals each have a vibraculum budded off from their distal ends (although not quite in the plane of the longitudinal axis of the zooecium). Thus the apparent difference in situation of the vibracula depends merely on the zoarial form of the colony, the morphological relations of zooecium and vibraculum in both species being identical. If this suggestion is confirmed, *Cupuladria* will pass into the synonymy of *Heliodoma.*

Distribution.—In the Tertiary deposits of southern Victoria, *O. cupola spiralis* has been found only in the Upper Oligocene at the present locality, whereas in the Murray Gulf it persisted until the Miocene (Chapman, 1913, p. 185). *O. cupola cupola* is very widely distributed in Victorian Lower Miocene deposits, additional localities to those listed by Maplestone (1904, *b*) being Batesford tunnel marl and Forsyth's (below remanié nodule bed), Grange Burn Creek (Hamilton). Chapman (1922) has recorded "*Selenaria cupola*" down to 59 feet in the Torquay bore and it is possible that some of these may be *O. cupola spiralis.* Further records by Chapman (1916, 1928) indicate the occurrence of *O. cupola cupola* in the late Miocene and early Pliocene of the Mallee and Sorrento bores.

Family SCHIZOPORELLIDAE Bassler, 1935.

Escharellidae Levinsen, 1909, p. 314.

Schizoporellidae Bassler, 1935, p. 33.

Sub-family HIPPOPORININAE Bassler, 1935.

Hippoporae Canu and Bassler, 1917, p. 42; *idem,* 1920, p. 398; *id.*, 1927, p. 19; *id.*, 1929, p. 33. Darteville, 1933, p. 78.

Hippoporininae Bassler, 1935, p. 33.

Genus **Cucullipora** Macgillivray, 1895.

Cucullipora Macgillivray, 1895, p. 95. Canu and Bassler, 1929, pp. 34, 41. Bassler, 1935, p. 85.

Hippozeugosella (*pars*) Canu and Bassler, 1920, p. 398.

Observations.—The name changes of higher order than the genus are due to nonconformity with Article 4 of the International Rules of Zoological Nomenclature. The systematic position of this genus has been uncertain since its inception. Macgillivray's original placing of it in Smittinidae was altered to sub-family "Hippoporae" by Canu and Bassler (1920, p. 398) while the genus was combined with *Bactridium* Reuss, 1848, to form a new genus *Hippozeugosella* Canu and Bassler, 1917. Dartevelle (1933, p. 78), apparently in communication with Canu, states that Canu and Bassler now regard the three genera mentioned above as distinct. In 1935 Bassler transferred *Cucullipora* to Hippopodinidae Levinsen, 1909, following the suggestion of Canu and Bassler (1929, p. 41) that it is possibly related to *Watersipora* Neviani, 1895 (the character of the aperture, however, contradicts this), while *Hippozeugosella* was placed in the synonymy of *Bactridium,* both the latter having the same genotype.

The study of a large series of *Cucullipora tetrasticha* now shows that it is most closely related to *Hippoporina* Neviani, 1895, type of the sub-family Hippoporininae, thus agreeing with the first placing of Canu and Bassler. The evidence for this is provided by the typically Hippoporine form of the aperture and the large cardelles, the frontal being an olocyst. Although about fifty examples have been examined, none has been found bearing ovicells. From *Hippoporina* it differs in the form of the zoarium, hood-like peristome and the arrangement of the avicularia.

CUCULLIPORA TETRASTICHA Macgillivray, 1895.
(Pl. III., Fig. 4).

Cucullipora tetrasticha Macgillivray, 1895, p. 96, pl. xiii., fig. 13. Maplestone, 1904, *b*, p. 211. Dartevelle, 1933, p. 78. Bassler, 1935, p. 85.

Hippozeugosella tetrasticha (Macgillivray), Canu and Bassler, 1920, p. 398.

Dimensions.—Width of branch, 1.15 mm.; aperture, height 0.12, width 0.09; zooecium, length 0.56.

Distribution.—Lower Miocene: The following localities are additional to those listed by Maplestone (1904, *b*) :—Batesford tunnel marl, Curlewis marl.

Upper Oligocene: Torquay bore at 66-67 feet.

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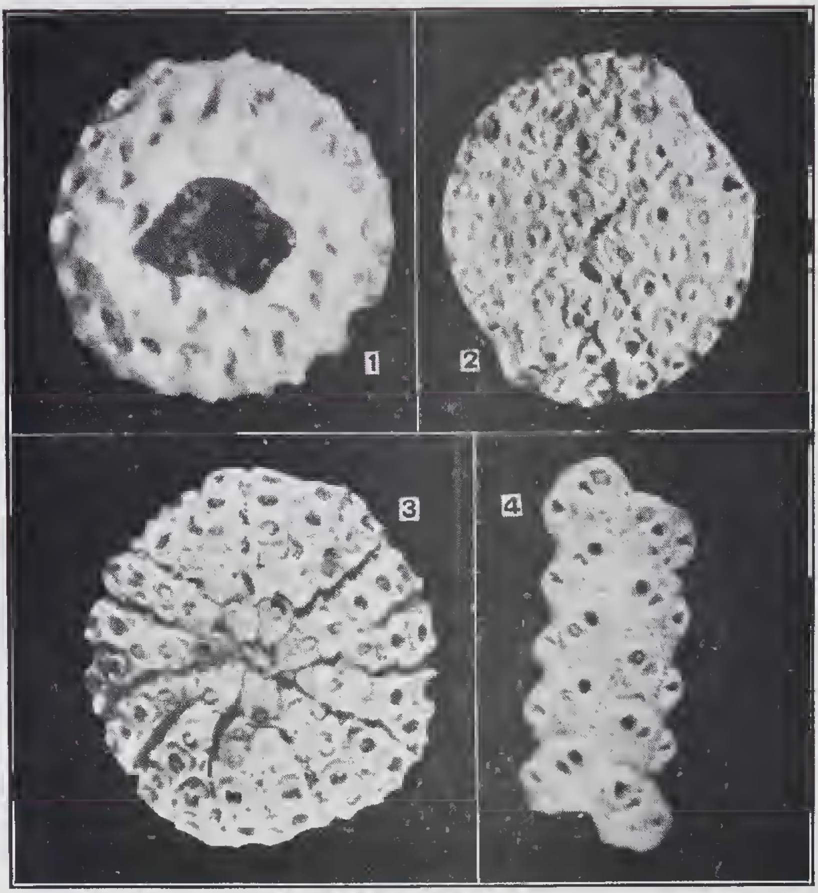

Upper Oligocene Bryozoa.

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Explanation of Plate III.

(Magnification × 17.5.)

Fig. 1.—*Otionella cupola spiralis* (Chapman). Mallee Bore No. 9 at 315–325 feet. Holotype, in National Museum, Melbourne (No. 12456), showing glauconitic grain as substratum for the zoarium, the first few whorls of the spirals having been abraded off.

Fig. 2.—*O. cupola spiralis* (Chapman). Torquay Bore at 66–67 feet. Plesiotype in National Museum, Melbourne (No. 14052), showing complete zoarium except for the slightly damaged ancestrular region.

Fig. 3.—*O. cupola* (T. Woods). "*Glycimeris* bed" at Torquay. Plesiotype in National Museum, Melbourne (No. 14053).

Fig. 4.—*Cucullipora tetrasticha* Macgillivray. Clifton Bank, Muddy Creek (Hamilton). Plesiotype in National Museum, Melbourne (No. 14054).